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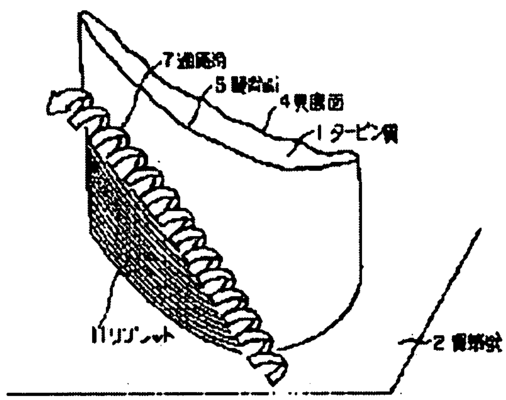
(71)Applicant : **MITSUBISHI HEAVY IND LTD**
(72)Inventor : **HIRANO YUICHIRO**

(54) AXIAL TURBINE BLADE

(57)Abstract:
PROBLEM TO BE SOLVED: To provide an axial turbine blade which is capable of reducing the friction loss and the pressure loss generated due to a two-dimensional flow produced in the neighborhood of the blade end part of a three-dimensional blade profile constituting a cascade of blades, and thereby improving the turbine efficiency.
SOLUTION: With the axial turbine blade, in order to relax the velocity gradient of a working fluid flowing with increasing the flow velocity in the direction crossing a blade back face 5 at right angles, which is brought about by a two-dimensional flow produced in a break away region formed between the blade back face 5 and passage eddies 7 flowing on the blade back face 5 toward the downstream side, and to reduce the friction loss generated by the blade back face 5, riblets 11, the top of each of which is formed into a sharp shape, are provided in the break away region formed between the blade end-wall 2 and the passage eddies 7. Troubles generated in conventional axial turbine blades due to the passage eddies can thus be eliminated.



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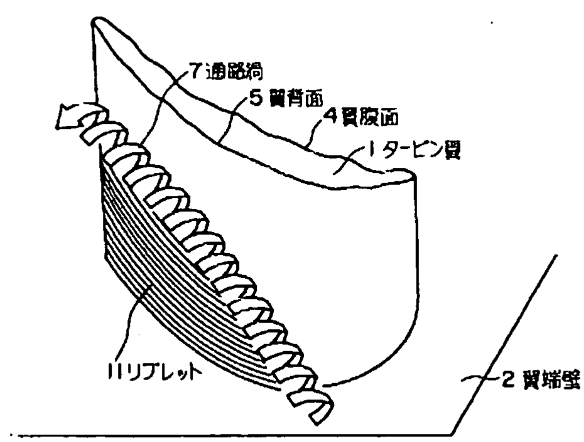
(71)出願人　000006208
三菱重工業株式会社
東京都千代田区丸の内二丁目５番１号
(72)発明者　平野　雄一郎
長崎市深堀町五丁目717番１号　三菱重工業株式会社長崎研究所内
(74)代理人　弁理士　石川　新　（外１名）

(54)【発明の名称】　軸流タービン翼

(57)【要約】　（修正有）
【課題】　翼列を構成する３次元翼型の翼端部近傍で発生する２次流れで発生する摩擦損失および圧力損失を低減し、タービン効率を向上させる軸流タービン翼を提供する。
【解決手段】　軸流タービン翼は、翼端壁２と翼背面５上を下流側へ流れていく通路渦７との間に形成される剥離領域に発生する２次流れによって誘起されて、翼背面５に直交する方向の流速を増大して流れる作動流体の速度勾配を緩和し、翼背面５で発生する摩擦損失を低減するために、翼端壁２と通路渦７とで挟まれて形成される剥離領域に、頂部に尖った形状を形成したリブレット１１を設ける構成にした。これにより、従来の軸流タービンで発生していた上述の不具合を解消することができる。



【特許請求の範囲】
【請求項１】　周方向に翼列を形成するように、翼端壁にタービン翼を立設して設けられた軸流タービン翼において、前記翼端壁と前記翼列内に形成され、流出する通路渦とで挟まれた前記タービン翼の翼背面上の剥離領域に、前記剥離領域に発生する２次流れ渦によって誘起されて、前記翼背面に直交して流れる作動流体の速度勾配を緩和し、前記翼背面で発生する摩擦損失を低減するような頂部を尖った形状にしたリブレットを設けたことを特徴とする軸流タービン翼。
【請求項２】　周方向に翼列を形成するように、翼端壁にタービン翼を立設して設けられた軸流タービン翼において、前記翼端壁近傍の前記タービン翼の前縁で形成され前記翼列内を流出する通路渦が、前記タービン翼の翼背面を横切る位置より前方の前縁部に、前記通路渦の前記翼背面上への移動を抑制し、前記翼背面上での圧力損失低減、および前記通路渦自体を弱体化して圧力損失を低減するとともに摩擦損失を低減させる、翼腹面から前記翼背面へ貫通させたバイパス通路を設けたことを特徴とする軸流タービン翼。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本発明は、蒸気タービン及びガスタービン等に利用され、翼列を構成する３次元翼型の翼端部近傍で発生する、２次流れ損失領域で発生する摩擦損失および圧力損失をそれぞれ低減し、性能を大幅に向上できる軸流タービン翼に関する。
【０００２】
【従来の技術】翼列を形成する３次元翼型の翼根、若しくは翼端近傍の翼端壁に発生する、２次流れにより発生した通路渦が発達して形成される損失領域で生じる摩擦損失、および圧力損失によって、大きな翼列損失が発生する軸流タービン翼においては、これらの損失領域で生じる、これらの翼列損失を低減することが性能向上上重要である。
【０００３】図５は、翼列を形成するように、翼端壁にタービン翼を周方向に立設して設けられた軸流タービン翼の翼列内部の流れの様子を示す模式図である。図に示すように、翼列上流の翼端壁２付近を流れる蒸気又は燃焼ガス等の作動流体Ｆの流れは、タービン翼１の前縁に衝突すると、翼端壁２側へ潜り込み、通路渦７を形成する。
【０００４】この通路渦７の渦管は、翼端壁２付近の翼前縁を取り巻くように形成され、１点鎖線で示すように、その形状から馬蹄渦３と呼ばれている。すなわち、隣接して配設されたタービン翼１の、一方のタービン翼１の翼腹面４と他方のタービン翼１の翼背面５とで挟まれて形成される翼列内部に形成される翼間流路８内における翼端壁２付近では、翼腹面４と翼背面５とにそれぞれ作用する作動流体Ｆの圧力差によって、翼腹面４側から翼背面５側に向けて流れる２次流れ６が形成される。
【０００５】このため、特に、作動流体Ｆがタービン翼１の前縁に衝突して生じる馬蹄渦３のうち、翼腹面４側へ流れる馬蹄渦３は、作動流体Ｆによって翼間流路８内を下流側へ流されるとともに、この２次流れ６により、翼間流路８尚を翼背面５側へと流されながら、通路渦７と呼ばれる大きな渦に発達する。この通路渦７の渦管は、下流へのびるにつれ翼背面５と翼端壁２に挟まれる翼間流路８のコーナ部を横切り、翼背面５に沿って翼高さ中央方向へ移動していく。図６は、従来の軸流タービン翼列の内部流れのうち、タービン翼１の翼背面５の翼端壁２近傍の流れの詳細を示すための断面図である。図において、７は作動流体Ｆの流れに垂直な断面で見た通路渦であり、図に示すように、翼背面５側へ２次流れ６で流された通路渦７は、翼背面５に沿って下流側へ流れていく。
【０００６】このため、この通路渦７は、翼端壁２および翼背面５から離れた位置を流れている作動流体Ｆを加速した高速流体９を翼背面５付近へ巻き込むことになる。この結果、翼背面５上の翼端壁２から通路渦７にかけての剥離領域Ｓでは、翼背面５に垂直な方向の高速流体９の速度勾配が急になり、翼背面５で生じる壁面摩擦による高速流体９の運動量の損失が急激に大きくなる。
【０００７】しかも、こうして大きな運動量を損失し、発生した圧力損失の大きくなった圧損流体１０は、さらに通路渦７の回転運動によってタービン翼１の高さ中央方向へ掃き出されながら下流側へ流れるため、翼端壁２と通路渦７に挟まれる剥離領域７のタービン翼１の翼幅方向の高さが大きくなり、換言すれば、翼背面５の大きな部分が常に高速流体９にさらされていることになり、大きな圧力損失の発生源となり、タービン効率が大幅に低下するという不具合があった。
【０００８】なお、通路渦７のうち、当該通路渦７を発生させた前縁を設けたタービン翼１の背面側５へ流れる通路渦７は、２次流れによって当該タービン翼１の背面側５に押しつけられた状態で下流側へ流れるため、この通路渦７の渦管は、下流にのびるにつれ翼間流路８へ移動することがなく、従って、当該タービン翼１の背面側５の翼高さ中央方向へ移動することが少なく、後述するような、隣接するタービン翼１の背面側５へ向けてのびる通路渦７によって発生する不具合は殆んど生じない。
【０００９】
【発明が解決しようとする課題】本発明は、上述した現状に鑑み、３次元翼型の翼端部で生じる２次流れ損失領域において生じる摩擦損失および圧力損失を低減し、大幅なタービン翼の性能向上を図ることができるようにした、軸流タービン翼を提供することを課題とする。
【００１０】
【課題を解決するための手段】このため、本発明の軸流タービン翼は、次の手段とした。

（１）翼端壁と翼端壁に周方向に立設された翼列を形成するタービン翼の翼背面上に沿って下流側へ流れていく通路渦との間に形成される剥離領域に発生する２次流れによって誘起されて、翼背面に直交する方向の流速を増大して流れるようになる作動流体の速度勾配を緩和し、翼背面で発生する摩擦損失を低減するために、翼端壁と翼列内に発生する通路渦とで挟まれて形成される剥離領域のタービン翼の翼背面上に、頂部に尖った形状を形成したリブレットを設けた。なお、リブレットは、尖った形状を複数頂部に設けるとともに、尖った形状が同一翼幅方向を翼背面に作動流体の流れの方向に沿って形成されるものにすることが好ましい。

【００１１】本発明の軸流タービン翼は、上述（１）の手段により、（ａ）タービン翼前縁で発生して翼背面上に移動した通路渦は、翼背面から離れた位置にある高速流体を、従来の軸流タービン翼と同様に翼背面付近へ巻き込むが、この高速流体が直接に翼背面に接触するのは、剥離領域のタービン翼の翼背面上に設けたリブレットの頂部の尖った領域のみとなる。さらに、通路渦によって巻き込まれ加速される高速流体は、リブレットにより減速され、速度勾配が小さくなる。

【００１２】これにより、翼背面で生じる壁面摩擦を小さくすることができ、高速流体の運動等の損失を小さくできる。また、リブレットとの摩擦により発生した圧力損失の大きい圧損流体は、翼高さ中央方向へ掃き出されずに、リブレットに沿って下流側へ流れるため、通路渦によって壁面付近へ巻き込まれた高速流体は、翼背面との間に圧力損失の大きな流体を介して流れることになる。このように、翼背面の翼端壁付近の翼背面の垂直な方向の速度勾配は、緩和され、翼背面における壁面摩擦による損失の発生を抑制することができる。

【００１３】また、本発明の軸流タービン翼は、次の手段とした。

（２）翼端壁に周方向に立設され翼列を形成するタービン翼の翼背面側に沿って下流側へ流れていく、通路渦のタービン翼前縁から翼背面上への移動を抑制し、翼背面上での圧力損失低減、および通路渦自体の弱体化による圧力損失低減を行うために、翼端壁近傍のタービン翼の前縁で発生し、翼列内の隣接するタービン翼の翼背面側にのびて流れる通路渦が、下流側へ流れて翼背面を横切る位置からタービン翼の前縁部に、翼腹面から翼背面へ貫通するバイパス通路を設けた。なお、バイパス通路はコード方向に単数若しくは複数設けるようにしても良く、、さらに翼幅方向に多段にわたって設けるようにしても良い。

【００１４】本発明の軸流タービン翼は、上述（２）の手段により、タービン翼の前縁で発生する通路渦は、タービン翼に翼腹面から翼背面へ貫通するバイパス通路が設けられており、バイパス通路内には、圧力差によって、翼腹面から翼背面へ流れるバイパス流れが発生するので、翼背面側への移動が抑制されるとともに、渦強度も弱められる。

【００１５】すなわち、バイパス流れの向きは、翼端壁付近における翼ピッチ方向の成分でみると、２次流れの方向及び通路渦の渦管の方向と逆向きとなることから、バイパス流れは、通路渦の発達と通路渦の翼背面上への移動を抑制することとなる。これによって、通路渦がタービン翼前縁の翼端壁上から隣接して配置されたタービン翼の翼背面上への移動は、翼背面の下流側へ移動するため、翼背面において、通路渦が高速流体を翼背面付近へ巻き込むことにより発生する翼背面における壁面摩擦の大きい領域は小さくなり、摩擦抵抗が低減し、これに伴い作動流体の圧力損失の低減が達成される。さらに、バイパス流れによる通路渦自体の渦強度も弱体化され、これによっても、翼背面上における摩擦損失および圧力損失は低減される。

【００１６】

【発明の実施の形態】以下、本発明の軸流タービン翼の実施の一形態を図面にもとづき説明する。図１は本発明の軸流タービン翼の実施の第１形態を示す部分斜視図、図２は図１に示す実施の第１形態に関わる軸流タービン翼列内部流れの断面図である。なお、前述した図５、図６に示す軸流タービン翼と同一部材、若しくは類似の部材には同一符号を付して説明を省略する。

【００１７】図１、図２において、１１は流れに平行に多数段設けられたリブレット、高速流体９の流れの方向に平行に０．０５ｍｍ程度のＶ字形などのノッチをつけたものであり、翼背面５上にのびる通路渦７と翼端壁２によって囲まれ、タービン翼１の後縁側に形成される三角形の剥離領域Ｓに設置される。

【００１８】図２において、詳細に示すように、リブレット１１の頂部は、鋭く尖った形状が複数形成されるとともに、鋭く尖った形状は翼幅方向の略一定位置毎に等ピッチに配置されるようにして複数本、翼背面５の剥離領域に設けるようにしている。また、リブレット１１に挟まれてなる溝（ノッチ）内には、圧力損失の大きくなった圧損流体１０が存在し、リブレット１１と平行に後流側へ流す。

【００１９】本実施の形態の軸流タービン翼によれば、従来の軸流タービン翼と同様に翼背面５へのびる通路渦７は、翼端壁２および翼背面５壁面から離れた位置にある高速流体９を翼背面５上付近に巻き込むが、巻込みにより加速されて、速度勾配が大きくなった高速流体９が、直接に翼背面５に接触するのはリブレット１１頂部の尖った領域のみとなり、高速流体９の翼背面との摩擦による壁面摩擦は小さくでき、高速流体９の運動量の損失を小さくできる。

【００２０】すなわち、翼背面５の翼端壁２付近に発生する、翼背面５に垂直な方向の速度勾配は、リブレット１１により緩和されるとともに、接触面積を小さくする

ことにより、翼背面５における壁面摩擦を低減することにより、高速流体９の圧力損失の発生を抑制することができる。

【００２１】また、リブレット１１との摩擦により発生した圧力損失の大きい圧損流体１０は、翼高さ中央方向へ掃き出されずに、リブレット１１のノッチ内に沿って下流へ流れるため、通路渦７によって壁面付近へ巻き込まれた高速流体９は、圧損流体１０と混合することが抑制され、高速流体９は、翼背面５との間に圧損流体１０を介して流れるため、圧力損失を生じることなく、下流側へ流出する。

【００２２】このように、本実施の形態の軸流タービン翼では、翼背面５上の翼端壁２と通路渦７に挟まれる剥離領域Ｓにリブレット１１を設けることにより、剥離領域において、２次流れ渦によって誘起される翼背面に垂直な方向の高速流体９の速度勾配を緩和し、壁面摩擦による損失の発生を抑制することができるとともに、高速流体９と圧損流体１０との混合を抑制し、高速流体９の圧力損失を低減し、タービン効率の大幅な向上を図ることができる。

【００２３】次に、図３は本発明の軸流タービン翼の実施の第２形態を示す部分斜視図、図４は図３に示す実施の第２形態に関わる軸流タービン翼列内部流れの断面図である。

【００２４】これらの図においても、前述した図５、図６に示す軸流タービン翼と同一部材、若しくは類似の部材には同一符号を付して説明は省略する。図３、図４において、１２はバイパス通路、１３はバイパス流れである。バイパス通路は、タービン翼１の前縁から発生して、２次流れ６によって隣接するタービン翼１の翼背面５上へのびる通路渦７の渦管が、翼端壁２と翼背面５との交線を横切る位置からタービン翼１への前縁にかけて、翼腹面４から翼背面５へタービン翼１を貫通するよう、翼端壁２付近に翼弦方向に１個以上設けるようにしている。

【００２５】図４に示すように、バイパス通路１２を設ける部分を流出する通路渦７は、略翼端壁２上にあり、タービン翼１に翼腹面４から翼背面５へ貫通させて設けた、バイパス通路１２内には、翼腹面４と翼背面５との間の圧力差によって、バイパス流れ１３が発生する。バイパス流れ１３の向きは、翼端壁２付近における翼ピッチ方向の成分でみると、２次流れ６の方向及び通路渦７の渦管の方向と逆向きとなることから、バイパス流れ１３は、通路渦７の渦強さを弱めて、通路渦７の発達を抑制するとともに、隣接するタービン翼１の前縁で発生した通路渦７の翼背面５上への移動を抑制する。

【００２６】これによって、タービン翼１の前縁の翼端壁２で発生して、隣接して配置されたタービン翼１の翼背面５上へ移動する通路渦７は、翼幅方向、すなわち翼高さ中央方向へ移動せずに、翼背面５の翼端壁２近くを下流側へ移動することとなり、翼背面５において、通路渦７が前述した高速流体９を翼背面５付近へ巻き込むことにより発生する、翼背面における壁面摩擦の大きくなる剥離領域Ｓは小さくなり、摩擦損失が低減し、これに伴い、作動流体Ｆの圧力損失の低減が達成される。さらに、前述したバイパス流れ１３による通路渦７自体の渦強度の弱体化によっても、翼背面５上における摩擦損失および圧力損失は低減され、高速流体９の圧力損失を低減し、タービン効率の大幅な向上を図ることができる。

【００２７】

【発明の効果】以上、説明したように、本発明の軸流タービン翼によれば、翼端壁と翼背面上を下流側へ流れていく通路渦との間に形成される剥離領域に発生する２次流れによって誘起されて、翼背面に直交する方向の流速を増大して流れる作動流体が加速された高速流体の速度勾配を緩和し、翼背面で発生する摩擦損失を低減するために、翼端壁と通路渦とで挟まれて形成される剥離領域に、頂部に尖った形状を形成したリブレットを設ける構成にした。

【００２８】これにより、翼背面上に移動した通路渦は、翼背面から離れた位置を流れる作動流体が加速された高速流体を、翼背面付近へ巻き込むが、この高速流体が直接に翼背面に接触するのは、剥離領域のタービン翼の翼背面上に設けたリブレットの頂部の尖った領域のみとなり、また、通路渦によって加速される高速流体は、リブレットにより減速され、速度勾配が小さくなる。従って、翼背面で生じる壁面摩擦を小さくすることができる、高速流体の運動量の損失を小さくできる。

【００２９】また、リブレットとの摩擦により発生した圧力損失の大きい圧損流体は、翼高さ中央方向へ掃き出されずに、リブレットに沿って下流側へ流れ、通路渦によって壁面付近へ巻き込まれた高速流体は、翼背面との間に、圧力損失の大きな流体を介して流れることになる。この翼背面の翼端壁付近の、翼背面に垂直な方向の速度勾配の緩和、および翼背面における壁面摩擦による損失の発生を抑制することにより、タービン効率を向上させることができる。

【００３０】また、本発明の軸流タービン翼によれば、（２）タービン翼の翼背面側に沿って下流側へ流れていく、通路渦のタービン翼前縁から翼背面上への移動を抑制し、翼背面上での圧力損失低減、および通路渦自体の弱体化による圧力損失低減を行うために、翼端壁近傍のタービン翼の前縁から、翼列内の翼背面側にのびて流れる通路渦が、下流側へ流れてタービン翼の翼背面を横切る位置にかけて、翼腹面から翼背面へ貫通するバイパス通路を設けた。このように、タービン翼に翼腹面から翼背面へ貫通するバイパス通路が設けられ、バイパス通路内には、翼腹面から翼背面へ流れるバイパス流れが発生するので、通路渦の翼背面側への移動が抑制されるとともに、渦強度も弱められる。

【0031】これによって、通路渦がタービン翼前縁の翼端壁上から翼背面上への移動は、翼背面の下流側へ移動するため、翼背面において、通路渦が高速流体を翼背面付近へ巻き込むことにより発生する、翼背面における壁面摩擦の大きくなる剥離領域は、小さくなり、摩擦損失が低減し、これに伴い作動流体の圧力損失の低減が達成される。さらに、バイパス流れによる通路渦自体の渦強度も弱体化され、これによっても、翼背面上における摩擦損失および圧力損失は低減される。このように摩擦損失、圧力損失の低減によりタービン効率を向上させることができる。

【図面の簡単な説明】

【図１】本発明の軸流タービン翼の実施の第１形態を示す部分斜視図、

【図２】図１に示す実施の第１形態に関わる軸流タービン翼列内部流れの断面図、

【図３】本発明の軸流タービン翼の実施の第２形態を示す部分斜視図、

【図４】図３に示す実施の第２形態に関わる軸流タービン翼列内部流れの断面図、

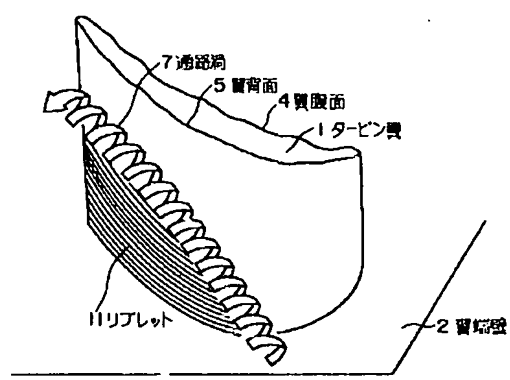
【図５】翼端壁にタービン翼を周方向に立設して設けられた、従来の軸流タービン翼の翼列内部の流れの様子を示す模式図、

【図６】図５に示す従来の軸流タービン翼列の内部流れのうち、タービン翼の翼背面の翼端壁近傍の流れの詳細を示すための断面図である。

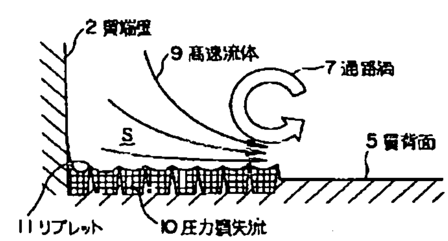
【符号の説明】

１　タービン翼
２　翼端壁
３　馬蹄渦
４　翼腹面
５　翼背面
６　２次流れ
７　通路渦
８　翼間通路
９　高速流体
１０　圧損流体
１１　リブレット
１２　バイパス通路
１３　バイパス流れ
Ｆ　作動流体
Ｓ　剥離領域

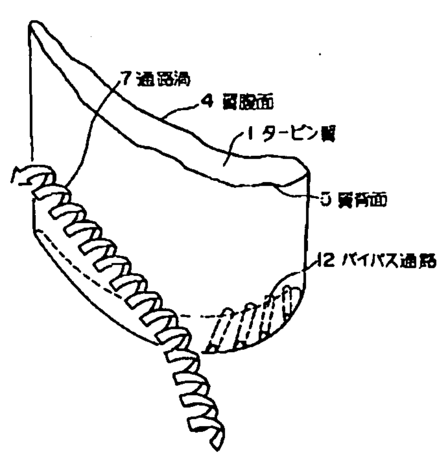
【図１】



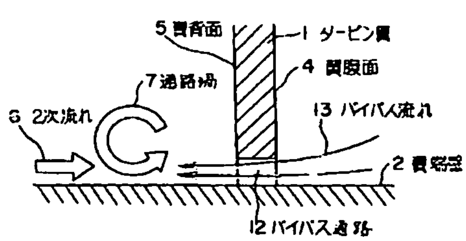
【図２】



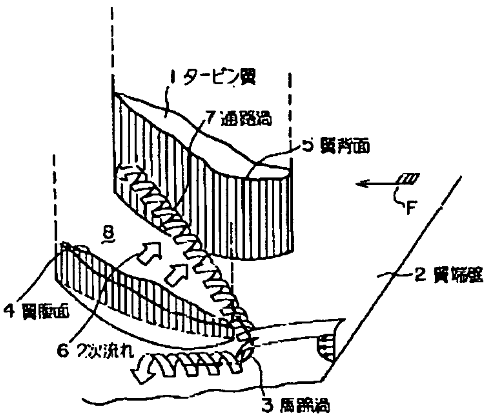
【図３】



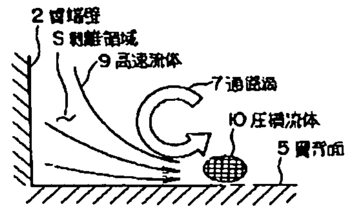
【図４】



【図５】


1 タービン翼
7 通路渦
5 翼背面
F
2 翼端壁
8
4 翼腹面
6 2次流れ
3 馬蹄渦

【図６】


2 翼端壁
S 剥離領域
9 高速流体
7 通路渦
10 圧損流体
5 翼背面

CLAIMS

[Claim(s)]
[Claim 1] In the axial-flow-turbine aerofoil which set up the turbine blade to the aerofoil end wall, and was prepared in it so that a cascade might be formed in a hoop direction To the exfoliation field on the aerofoil tooth back of said turbine blade pinched by the path eddy which is formed in said aerofoil end wall and said cascade, and flows out The axial-flow-turbine aerofoil characterized by preparing Libretto which made a crowning which reduces the friction loss which induction is carried out, eases the velocity gradient of the working fluid which intersects perpendicularly with said aerofoil tooth back, and flows, and is generated at said aerofoil tooth back by the secondary flow eddy generated to said exfoliation field the configuration where it sharpened.
[Claim 2] In the axial-flow-turbine aerofoil which set up the turbine blade to the aerofoil end wall, and was prepared in it so that a cascade might be formed in a hoop direction The path eddy which is formed in the first transition of said turbine blade near [said] the aerofoil end wall, and flows out the inside of said cascade Migration of a up to [said aerofoil tooth back of said path eddy] is controlled in the front first transition section from the location which crosses the aerofoil tooth back of said turbine blade. The axial-flow-turbine aerofoil characterized by preparing the bypass path made to penetrate to said aerofoil tooth back from the aerofoil intrados which reduces friction loss while weakening the pressure loss reduction on said aerofoil tooth back, and said path eddy itself and reducing pressure loss.

[Translation done.]

* NOTICES *

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1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention is used for a steam turbine, a gas turbine, etc., reduces the friction loss and pressure loss which are generated near the aerofoil edge of the three-dimension profile which constitutes a cascade and which are generated in a secondary flow loss field, respectively, and relates to the axial-flow-turbine aerofoil which can improve the engine performance sharply.
[0002]
[Description of the Prior Art] It is an improvement overlay important point in the engine performance to reduce these cascade loss produced in these loss fields in the axial-flow-turbine aerofoil which big cascade loss generates by the friction loss produced in the loss field in which the path eddy which is generated in the wing joint of the three-dimension profile which forms a cascade, or the aerofoil end wall near the wing tip, and which was generated by secondary flow is formed by progressing, and pressure loss.
[0003] Drawing 5 is the mimetic diagram showing the situation of the flow inside the cascade of the axial-flow-turbine aerofoil which set up the turbine blade to the hoop direction and was prepared in the aerofoil end wall, as a cascade is formed. As shown in drawing, if the flow of the working fluids F, such as a steam which flows near [aerofoil end-wall 2] the cascade upstream, or combustion gas, collides with the first transition of a turbine blade 1, it will be hidden in the aerofoil end-wall 2 side, and will form the path eddy 7.
[0004] The vortex tube of this path eddy 7 is formed so that the leading edge of the aerofoil end-wall 2 neighborhood may be surrounded, and as a dashed line shows, it is called the horseshoe vortex 3 from that configuration. That is, near [in the passage 8 between aerofoils formed in the interior of the cascade inserted and formed at the aerofoil intrados 4 of one turbine blade 1 of a turbine blade 1 and the aerofoil tooth back 5 of the turbine blade 1 of another side which were arranged adjacently / aerofoil end-wall 2], the secondary flow 6 which flows towards the aerofoil tooth-back 5 side by the differential pressure of the working fluid F which acts, respectively from the aerofoil intrados 4 side is formed in the aerofoil intrados 4 and the aerofoil tooth back 5.
[0005] For this reason, especially the horseshoe vortex 3 to which a working fluid F flows to the aerofoil intrados 4 side among the horseshoe vortexes 3 collided and produced in the first transition of a turbine blade 1 develops into the big eddy called the path eddy 7 by this secondary flow 6, passing passage 8 ** between aerofoils to the aerofoil tooth-back 5 side while being passed in the inside of the passage 8 between aerofoils with a working fluid F to the downstream. The vortex tube of this path eddy 7 crosses the corner section of the aerofoil tooth back 5 and the passage 8 between aerofoils inserted into the aerofoil end wall 2 as it is extended to a lower stream of a river, and it moves in the direction of a center in aerofoil height along the aerofoil tooth back 5. Drawing 6 is a sectional view to show the detail of about two aerofoil end wall [on the tooth back 5 of an aerofoil of a turbine blade 1] flow among the internal flows of the conventional axial-flow-turbine cascade. In drawing, 7 is the path eddy seen in the cross section perpendicular to the flow of a working fluid F, and as shown in drawing, the path eddy 7

passed by the secondary flow 6 to the aerofoil tooth-back 5 side flows to the downstream along the aerofoil tooth back 5.

[0006] For this reason, this path eddy 7 will involve the high-speed fluid 9 which accelerated the working fluid F which is flowing the location distant from the aerofoil end wall 2 and the aerofoil tooth back 5 in the aerofoil tooth-back 5 neighborhood. Consequently, in the exfoliation field S applied to the path eddy 7 from the aerofoil end wall 2 on the aerofoil tooth back 5, the velocity gradient of the high-speed fluid 9 of a direction perpendicular to the aerofoil tooth back 5 becomes sudden, and loss of the momentum of the high-speed fluid 9 by the wall friction produced at the aerofoil tooth back 5 becomes large rapidly.

[0007] And the pressure-loss fluid 10 which lost a big momentum in this way and became large [the generated pressure loss] In order to flow to the downstream, being swept out furthermore by rotation of the path eddy 7 in the direction of a height center of a turbine blade 1, The height of the span direction of the turbine blade 1 of the exfoliation field 7 inserted into the aerofoil end wall 2 and the path eddy 7 became large, when putting in another way, the big part on the tooth back 5 of an aerofoil will always be exposed to the high-speed fluid 9, and became the generation source of big pressure loss, and there was fault that a turbine efficiency fell sharply.

[0008] In addition, the path eddy 7 which flows to tooth-back side 5 of the turbine blade 1 which prepared the first transition which generated the path eddy 7 concerned among the path eddies 7 After having been pushed against tooth-back side 5 of the turbine blade 1 concerned by secondary flow, in order to flow to the downstream, the vortex tube of this path eddy 7 It is rare not to move to the passage 8 between aerofoils, therefore to move in the direction of a center in the aerofoil height of tooth-back side 5 of the turbine blade 1 concerned, and the fault generated by the path eddy 7 extended towards tooth-back side 5 of the turbine blade 1 which is mentioned later, and which adjoins does not have ********** as it is extended down-stream.

[0009]

[Problem(s) to be Solved by the Invention] This invention makes it a technical problem to offer the axial-flow-turbine aerofoil which reduces the friction loss and pressure loss which are produced in the secondary flow loss field produced at the aerofoil edge of a three-dimension profile in view of the present condition mentioned above, and enabled it to aim at improvement in the engine performance of a large turbine blade.

[0010]

[Means for Solving the Problem] For this reason, the axial-flow-turbine aerofoil of this invention was made into the following means.

(1) Induction is carried out by the secondary flow generated to the exfoliation field formed between the path eddies which flow to the downstream along the aerofoil tooth-back top of the turbine blade which forms the cascade set up by the aerofoil end wall and the aerofoil end wall in the hoop direction. In order to reduce the friction loss which eases the velocity gradient of the working fluid which increases the rate of flow of the direction which intersects perpendicularly with an aerofoil tooth back, and comes to flow, and is generated at an aerofoil tooth back Libretto in which the configuration where it sharpened in the crowning was formed on the aerofoil tooth back of the turbine blade of the exfoliation field faced across and formed by the aerofoil end wall and the path eddy generated in a cascade was prepared. In addition, it is desirable that the configuration where it sharpened makes the same span direction what is formed in an aerofoil tooth back along the flow direction of a working fluid while Libretto prepares the configuration where it sharpened in two or more crownings.

[0011] The path eddy which generated in (a) turbine leading edge with the above-mentioned (1) means, and the axial-flow-turbine aerofoil of this invention moved onto the aerofoil tooth back Although the high-speed fluid in the location distant from the aerofoil tooth back is involved in near an aerofoil tooth back like the conventional axial-flow-turbine aerofoil, that this high-speed fluid contacts an aerofoil tooth back directly becomes only the field where the crowning of Libretto prepared on the aerofoil tooth back of the turbine blade of an exfoliation field sharpened. Furthermore, the high-speed fluid involved in and accelerated by the path eddy is slowed down by Libretto, and a velocity gradient becomes small.

/

[0012] Wall friction produced at an aerofoil tooth back can be made small by this, and loss of movement of a high-speed fluid etc. can be made small. Moreover, since the large pressure-loss fluid of pressure loss generated by friction with Libretto flows to the downstream along with Libretto, without being swept out in the direction of a center in aerofoil height, the high-speed fluid involved in near the wall surface will flow through the big fluid of pressure loss between aerofoil tooth backs by the path eddy. Thus, it is eased and the velocity gradient of the direction where the aerofoil tooth back near the aerofoil end wall on the tooth back of an aerofoil is perpendicular can control generating of loss by the wall friction in an aerofoil tooth back.

[0013] Moreover, the axial-flow-turbine aerofoil of this invention was made into the following means. (2) Along with the aerofoil tooth-back side of the turbine blade which is set up by the aerofoil end wall in a hoop direction, and forms a cascade, flow to the downstream. In order to control the migration from the turbine leading edge of a path eddy to an aerofoil tooth-back top and to perform pressure loss reduction on an aerofoil tooth back, and pressure loss reduction by the weakened path eddy itself It generated in the first transition of the turbine blade near the aerofoil end wall, and the bypass path penetrated from aerofoil intrados to an aerofoil tooth back was established in the first transition section of a turbine blade from the location where the path eddy which extends and flows to the aerofoil tooth-back side of the turbine blade adjoined within a cascade flows to the downstream, and crosses an aerofoil tooth back. in addition, a bypass path -- the direction of a code -- an unit -- or you may make it prepare more than one, and may make it prepare in multistage covering the span direction further

[0014] The bypass path penetrated to an aerofoil tooth back is established in the turbine blade from aerofoil intrados, and the path eddy which generates the axial-flow-turbine aerofoil of this invention with the above-mentioned (2) means in the first transition of a turbine blade can also weaken eddy reinforcement while the migration by the side of an aerofoil tooth back is controlled, since the bypass flow which flows from aerofoil intrados to an aerofoil tooth back by differential pressure occurs in a bypass path.

[0015] That is, if the bypass flow direction is seen of the component of the aerofoil pitch direction in near an aerofoil end wall, since it will turn into a secondary flow direction and the direction of the vortex tube of a path eddy, and reverse sense, bypass flow will control development of a path eddy, and migration of a up to [the aerofoil tooth back of a path eddy]. In order that migration of a up to [the aerofoil tooth back of a turbine blade where the path eddy adjoined and has been arranged from the aerofoil end wall of the turbine leading edge by this] may move to the downstream on the tooth back of an aerofoil, in an aerofoil tooth back, the large field of the wall friction in the aerofoil tooth back generated when a path eddy involves a high-speed fluid in near an aerofoil tooth back becomes small, frictional resistance decreases, and reduction of the pressure loss of a working fluid is attained in connection with this. Furthermore, the eddy reinforcement of the path eddy by bypass flow itself is also weakened, and the friction loss and pressure loss on an aerofoil tooth back are reduced by this.

[0016]

[Embodiment of the Invention] Hereafter, one gestalt of operation of the axial-flow-turbine aerofoil of this invention is explained based on a drawing. The partial perspective view in which drawing 1 shows the 1st gestalt of operation of the axial-flow-turbine aerofoil of this invention, and drawing 2 are the sectional views of the axial-flow-turbine cascade internal flow in connection with the 1st gestalt of operation shown in drawing 1 . In addition, the same sign is given to the same member as drawing 5 mentioned above and the axial-flow-turbine aerofoil shown in drawing 6 , or a similar member, and explanation is omitted.

[0017] In drawing 1 and drawing 2 , 11 attaches notches, such as about 0.05mm V typeface, in parallel with the flow direction of Libretto and the high-speed fluid 9 prepared several many steps in parallel with flow, is surrounded by the path eddy 7 and the aerofoil end wall 2 which are extended on the aerofoil tooth back 5, and is installed in the exfoliation field S of the triangle formed in the trailing-edge side of a turbine blade 1.

[0018] As shown in a detail, while two or more formation of the configuration where the crowning of Libretto 11 sharpened keenly is carried out, he is trying to prepare it in the exfoliation field on two or

more and the tooth back 5 of an aerofoil in drawing 2 , as the configuration where it sharpened keenly is arranged at pitches [location / of the span direction / every / abbreviation fixed]. moreover, in the slot (notch) which it comes to insert into Libretto 11, the pressure-loss fluid 10 which became large [pressure loss] exists, and it passes to a back-wash side in parallel with Libretto 11.

[0019] According to the axial-flow-turbine aerofoil of the gestalt of this operation, the path eddy 7 extended to the aerofoil tooth back 5 like the conventional axial-flow-turbine aerofoil Although the high-speed fluid 9 in the location distant from the aerofoil end wall 2 and aerofoil tooth-back 5 wall surface is involved in near the aerofoil tooth-back 5 top It is accelerated by entrainment, and that the high-speed fluid 9 with which the velocity gradient became large contacts the aerofoil tooth back 5 directly becomes only the field where Libretto 11 crowning sharpened, and wall friction by friction with the aerofoil tooth back of the high-speed fluid 9 can be performed small, and can make small loss of the momentum of the high-speed fluid 9.

[0020] That is, the velocity gradient of a direction perpendicular to the aerofoil tooth back 5 generated near [aerofoil end-wall 2] the aerofoil tooth back 5 can control generating of the pressure loss of the high-speed fluid 9 by reducing the wall friction in the aerofoil tooth back 5 by making a touch area small while being eased by Libretto 11.

[0021] Moreover, the large pressure-loss fluid 10 of pressure loss generated by friction with Libretto 11 In order to flow to a lower stream of a river along the inside of the notch of Libretto 11, without being swept out in the direction of a center in aerofoil height, the high-speed fluid 9 involved in near the wall surface by the path eddy 7 Mixing with the pressure-loss fluid 10 is controlled, and the high-speed fluid 9 flows into the downstream, without producing pressure loss, in order to flow through the pressure-loss fluid 10 between the aerofoil tooth backs 5.

[0022] thus, with the axial-flow-turbine aerofoils of the gestalt of this operation By forming Libretto 11 in the exfoliation field S inserted into the aerofoil end wall 2 and the path eddy 7 on the aerofoil tooth back 5 While being able to ease the velocity gradient of the high-speed fluid 9 of a direction perpendicular to the aerofoil tooth back as for which induction is carried out by the secondary flow eddy in an exfoliation field and being able to control generating of loss by wall friction Mixing with the high-speed fluid 9 and the pressure-loss fluid 10 can be controlled, the pressure loss of the high-speed fluid 9 can be reduced, and large improvement in a turbine efficiency can be aimed at.

[0023] Next, the partial perspective view in which drawing 3 shows the 2nd gestalt of operation of the axial-flow-turbine aerofoil of this invention, and drawing 4 are the sectional views of the axial-flow-turbine cascade internal flow in connection with the 2nd gestalt of operation shown in drawing 3 .

[0024] Also in these drawings, the same sign is given to the same member as drawing 5 mentioned above and the axial-flow-turbine aerofoil shown in drawing 6 , or a similar member, and explanation is omitted. In drawing 3 and drawing 4 , 12 is a bypass path and 13 is bypass flow. It generates from the first transition of a turbine blade 1, and he is trying for the vortex tube of the path eddy 7 extended to up to the aerofoil tooth back 5 of the turbine blade 1 which adjoins by the secondary flow 6 to prepare in the aerofoil end-wall 2 neighborhood at one or more chordwises, bypass applying it to the first transition from the location which crosses the intersection on the aerofoil end wall 2 and the tooth back 5 of an aerofoil to a turbine blade 1, so that a turbine blade 1 may be penetrated from the aerofoil intrados 4 to the aerofoil tooth back 5.

[0025] As shown in drawing 4 , in the bypass path 12 which the path eddy 7 flowing out had on the abbreviation wing-tip wall 2, and was made to penetrate to a turbine blade 1 to the aerofoil tooth back 5, and prepared the part which forms the bypass path 12 in it from the aerofoil intrados 4, the bypass flow 13 occurs by the differential pressure between the aerofoil intrados 4 and the aerofoil tooth back 5. If the sense of the bypass flow 13 is seen of the component of the aerofoil pitch direction in the aerofoil end-wall 2 neighborhood, since it will turn into the direction of the secondary flow 6 and the direction of the vortex tube of the path eddy 7, and reverse sense, the bypass flow 13 While weakening the eddy strength of the path eddy 7 and controlling development of the path eddy 7, migration of a up to [the aerofoil tooth back 5 of the path eddy 7 generated in the first transition of the adjoining turbine blade 1] is controlled.

[0026] The path eddy 7 which moves to up to the aerofoil tooth back 5 of the turbine blade 1 which occurred and has been adjacently arranged by the aerofoil end wall 2 of the first transition of a turbine blade 1 by this Without moving in the direction of a center in the span direction, i.e., aerofoil height, about two aerofoil end wall on the tooth back 5 of an aerofoil will be moved to the downstream, and it sets at the aerofoil tooth back 5. The exfoliation field S of the wall friction in an aerofoil tooth back which is generated by involving the high-speed fluid 9 which the path eddy 7 mentioned above in the aerofoil tooth-back 5 neighborhood and which becomes large becomes small, friction loss decreases, and reduction of the pressure loss of a working fluid F is attained in connection with this. Furthermore, with the weakened eddy reinforcement of path eddy 7 the very thing by the bypass flow 13 mentioned above, the friction loss and pressure loss on the aerofoil tooth back 5 can be reduced, can reduce the pressure loss of the high-speed fluid 9, and can aim at large improvement in a turbine efficiency.
[0027]
[Effect of the Invention] As mentioned above, according to the axial-flow-turbine aerofoil of this invention, induction is carried out by the secondary flow which generates an aerofoil end-wall and aerofoil tooth-back top to the exfoliation field formed between the path eddies which flow to the downstream as explained. The velocity gradient of the high-speed fluid with which the working fluid which increases and flows the rate of flow of the direction which intersects perpendicularly with an aerofoil tooth back was accelerated was eased, and in order to reduce the friction loss generated at an aerofoil tooth back, it was made the configuration which prepares Libretto in which the configuration where it sharpened in the crowning was formed to the exfoliation field faced across and formed by the aerofoil end wall and the path eddy.
[0028] The path eddy which moved onto the aerofoil tooth back by this the high-speed fluid with which the working fluid which flows the location distant from the aerofoil tooth back was accelerated Although involved in near an aerofoil tooth back, the high-speed fluid which that this high-speed fluid contacts an aerofoil tooth back directly becomes only the field where the crowning of Libretto prepared on the aerofoil tooth back of the turbine blade of an exfoliation field sharpened, and is accelerated by the path eddy is slowed down by Libretto, and a velocity gradient becomes small. Therefore, loss of the momentum of the high-speed fluid which can make small wall friction produced at an aerofoil tooth back can be made small.
[0029] Moreover, the large pressure-loss fluid of pressure loss generated by friction with Libretto will flow to the downstream along with Libretto, without being swept out in the direction of a center in aerofoil height, and the high-speed fluid involved in near the wall surface by the path eddy will flow through the big fluid of pressure loss between aerofoil tooth backs. A turbine efficiency can be raised by controlling relaxation of the velocity gradient of a direction perpendicular to the aerofoil tooth back near the aerofoil end wall on this tooth back of an aerofoil, and generating of loss by the wall friction in an aerofoil tooth back.
[0030] Moreover, according to the axial-flow-turbine aerofoil of this invention, along with the aerofoil tooth-back side of (2) turbine blades, flow to the downstream. In order to control the migration from the turbine leading edge of a path eddy to an aerofoil tooth-back top and to perform pressure loss reduction on an aerofoil tooth back, and pressure loss reduction by the weakened path eddy itself It applied to the location where the path eddy which extends and flows from the first transition of the turbine blade near the aerofoil end wall to the aerofoil tooth-back side within a cascade flows to the downstream, and crosses the aerofoil tooth back of a turbine blade, and the bypass path penetrated from aerofoil intrados to an aerofoil tooth back was prepared. Thus, the bypass path penetrated from aerofoil intrados to an aerofoil tooth back to a turbine blade is prepared, and eddy reinforcement can also be weakened while the migration by the side of the aerofoil tooth back of a path eddy is controlled, since the bypass flow which flows from aerofoil intrados to an aerofoil tooth back occurs in a bypass path.
[0031] In order that a path eddy may move the migration from the aerofoil end wall of the turbine leading edge to an aerofoil tooth-back top to the downstream on the tooth back of an aerofoil, in an aerofoil tooth back, the exfoliation field of the wall friction in an aerofoil tooth back which is generated when a path eddy involves a high-speed fluid in near an aerofoil tooth back and which becomes large

becomes small, friction loss decreases, and reduction of the pressure loss of a working fluid is attained in connection with this by this. Furthermore, the eddy reinforcement of the path eddy by bypass flow itself is also weakened, and the friction loss and pressure loss on an aerofoil tooth back are reduced by this. Thus, a turbine efficiency can be raised by reduction of friction loss and pressure loss.

[Translation done.]

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TECHNICAL FIELD

[Field of the Invention] This invention is used for a steam turbine, a gas turbine, etc., reduces the friction loss and pressure loss which are generated near the aerofoil edge of the three-dimension profile which constitutes a cascade and which are generated in a secondary flow loss field, respectively, and relates to the axial-flow-turbine aerofoil which can improve the engine performance sharply.

[Translation done.]

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PRIOR ART

[Description of the Prior Art] It is an improvement overlay important point in the engine performance to reduce these cascade loss produced in these loss fields in the axial-flow-turbine aerofoil which big cascade loss generates by the friction loss produced in the loss field in which the path eddy which is generated in the wing joint of the three-dimension profile which forms a cascade, or the aerofoil end wall near the wing tip, and which was generated by secondary flow is formed by progressing, and pressure loss.
[0003] Drawing 5 is the mimetic diagram showing the situation of the flow inside the cascade of the axial-flow-turbine aerofoil which set up the turbine blade to the hoop direction and was prepared in the aerofoil end wall, as a cascade is formed. As shown in drawing, if the flow of the working fluids F, such as a steam which flows near [aerofoil end-wall 2] the cascade upstream, or combustion gas, collides with the first transition of a turbine blade 1, it will be hidden in the aerofoil end-wall 2 side, and will form the path eddy 7.
[0004] The vortex tube of this path eddy 7 is formed so that the leading edge of the aerofoil end-wall 2 neighborhood may be surrounded, and as a dashed line shows, it is called the horseshoe vortex 3 from that configuration. That is, near [in the passage 8 between aerofoils formed in the interior of the cascade inserted and formed at the aerofoil intrados 4 of one turbine blade 1 of a turbine blade 1 and the aerofoil tooth back 5 of the turbine blade 1 of another side which were arranged adjacently / aerofoil end-wall 2], the secondary flow 6 which flows towards the aerofoil tooth-back 5 side by the differential pressure of the working fluid F which acts, respectively from the aerofoil intrados 4 side is formed in the aerofoil intrados 4 and the aerofoil tooth back 5.
[0005] For this reason, especially the horseshoe vortex 3 to which a working fluid F flows to the aerofoil intrados 4 side among the horseshoe vortexes 3 collided and produced in the first transition of a turbine blade 1 develops into the big eddy called the path eddy 7 by this secondary flow 6, passing passage 8 ** between aerofoils to the aerofoil tooth-back 5 side while being passed in the inside of the passage 8 between aerofoils with a working fluid F to the downstream. The vortex tube of this path eddy 7 crosses the corner section of the aerofoil tooth back 5 and the passage 8 between aerofoils inserted into the aerofoil end wall 2 as it is extended to a lower stream of a river, and it moves in the direction of a center in aerofoil height along the aerofoil tooth back 5. Drawing 6 is a sectional view to show the detail of about two aerofoil end wall [on the tooth back 5 of an aerofoil of a turbine blade 1] flow among the internal flows of the conventional axial-flow-turbine cascade. In drawing, 7 is the path eddy seen in the cross section perpendicular to the flow of a working fluid F, and as shown in drawing, the path eddy 7 passed by the secondary flow 6 to the aerofoil tooth-back 5 side flows to the downstream along the aerofoil tooth back 5.
[0006] For this reason, this path eddy 7 will involve the high-speed fluid 9 which accelerated the working fluid F which is flowing the location distant from the aerofoil end wall 2 and the aerofoil tooth back 5 in the aerofoil tooth-back 5 neighborhood. Consequently, in the exfoliation field S applied to the path eddy 7 from the aerofoil end wall 2 on the aerofoil tooth back 5, the velocity gradient of the high-speed fluid 9 of a direction perpendicular to the aerofoil tooth back 5 becomes sudden, and loss of the

momentum of the high-speed fluid 9 by the wall friction produced at the aerofoil tooth back 5 becomes large rapidly.
[0007] And the pressure-loss fluid 10 which lost a big momentum in this way and became large [the generated pressure loss] In order to flow to the downstream, being swept out furthermore by rotation of the path eddy 7 in the direction of a height center of a turbine blade 1, The height of the span direction of the turbine blade 1 of the exfoliation field 7 inserted into the aerofoil end wall 2 and the path eddy 7 became large, when putting in another way, the big part on the tooth back 5 of an aerofoil will always be exposed to the high-speed fluid 9, and became the generation source of big pressure loss, and there was fault that a turbine efficiency fell sharply.
[0008] In addition, the path eddy 7 which flows to tooth-back side 5 of the turbine blade 1 which prepared the first transition which generated the path eddy 7 concerned among the path eddies 7 After having been pushed against tooth-back side 5 of the turbine blade 1 concerned by secondary flow, in order to flow to the downstream, the vortex tube of this path eddy 7 It is rare not to move to the passage 8 between aerofoils, therefore to move in the direction of a center in the aerofoil height of tooth-back side 5 of the turbine blade 1 concerned, and the fault generated by the path eddy 7 extended towards tooth-back side 5 of the turbine blade 1 which is mentioned later, and which adjoins does not have ********** as it is extended down-stream.

[Translation done.]

EFFECT OF THE INVENTION

[Effect of the Invention] As mentioned above, according to the axial-flow-turbine aerofoil of this invention, induction is carried out by the secondary flow which generates an aerofoil end-wall and aerofoil tooth-back top to the exfoliation field formed between the path eddies which flow to the downstream as explained. The velocity gradient of the high-speed fluid with which the working fluid which increases and flows the rate of flow of the direction which intersects perpendicularly with an aerofoil tooth back was accelerated was eased, and in order to reduce the friction loss generated at an aerofoil tooth back, it was made the configuration which prepares Libretto in which the configuration where it sharpened in the crowning was formed to the exfoliation field faced across and formed by the aerofoil end wall and the path eddy.
[0028] The path eddy which moved onto the aerofoil tooth back by this the high-speed fluid with which the working fluid which flows the location distant from the aerofoil tooth back was accelerated Although involved in near an aerofoil tooth back, the high-speed fluid which that this high-speed fluid contacts an aerofoil tooth back directly becomes only the field where the crowning of Libretto prepared on the aerofoil tooth back of the turbine blade of an exfoliation field sharpened, and is accelerated by the path eddy is slowed down by Libretto, and a velocity gradient becomes small. Therefore, loss of the momentum of the high-speed fluid which can make small wall friction produced at an aerofoil tooth back can be made small.
[0029] Moreover, the large pressure-loss fluid of pressure loss generated by friction with Libretto will flow to the downstream along with Libretto, without being swept out in the direction of a center in aerofoil height, and the high-speed fluid involved in near the wall surface by the path eddy will flow through the big fluid of pressure loss between aerofoil tooth backs. A turbine efficiency can be raised by controlling relaxation of the velocity gradient of a direction perpendicular to the aerofoil tooth back near the aerofoil end wall on this tooth back of an aerofoil, and generating of loss by the wall friction in an aerofoil tooth back.
[0030] Moreover, according to the axial-flow-turbine aerofoil of this invention, along with the aerofoil tooth-back side of (2) turbine blades, flow to the downstream. In order to control the migration from the turbine leading edge of a path eddy to an aerofoil tooth-back top and to perform pressure loss reduction on an aerofoil tooth back, and pressure loss reduction by the weakened path eddy itself It applied to the location where the path eddy which extends and flows from the first transition of the turbine blade near the aerofoil end wall to the aerofoil tooth-back side within a cascade flows to the downstream, and crosses the aerofoil tooth back of a turbine blade, and the bypass path penetrated from aerofoil intrados to an aerofoil tooth back was prepared. Thus, the bypass path penetrated from aerofoil intrados to an aerofoil tooth back to a turbine blade is prepared, and eddy reinforcement can also be weakened while the migration by the side of the aerofoil tooth back of a path eddy is controlled, since the bypass flow which flows from aerofoil intrados to an aerofoil tooth back occurs in a bypass path.
[0031] In order that a path eddy may move the migration from the aerofoil end wall of the turbine leading edge to an aerofoil tooth-back top to the downstream on the tooth back of an aerofoil, in an aerofoil tooth back, the exfoliation field of the wall friction in an aerofoil tooth back which is generated

when a path eddy involves a high-speed fluid in near an aerofoil tooth back and which becomes large becomes small, friction loss decreases, and reduction of the pressure loss of a working fluid is attained in connection with this by this. Furthermore, the eddy reinforcement of the path eddy by bypass flow itself is also weakened, and the friction loss and pressure loss on an aerofoil tooth back are reduced by this. Thus, a turbine efficiency can be raised by reduction of friction loss and pressure loss.

[Translation done.]

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TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] This invention makes it a technical problem to offer the axial-flow-turbine aerofoil which reduces the friction loss and pressure loss which are produced in the secondary flow loss field produced at the aerofoil edge of a three-dimension profile in view of the present condition mentioned above, and enabled it to aim at improvement in the engine performance of a large turbine blade.

[Translation done.]

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MEANS

[Means for Solving the Problem] For this reason, the axial-flow-turbine aerofoil of this invention was made into the following means.
(1) Induction is carried out by the secondary flow generated to the exfoliation field formed between the path eddies which flow to the downstream along the aerofoil tooth-back top of the turbine blade which forms the cascade set up by the aerofoil end wall and the aerofoil end wall in the hoop direction. In order to reduce the friction loss which eases the velocity gradient of the working fluid which increases the rate of flow of the direction which intersects perpendicularly with an aerofoil tooth back, and comes to flow, and is generated at an aerofoil tooth back Libretto in which the configuration where it sharpened in the crowning was formed on the aerofoil tooth back of the turbine blade of the exfoliation field faced across and formed by the aerofoil end wall and the path eddy generated in a cascade was prepared. In addition, it is desirable that the configuration where it sharpened makes the same span direction what is formed in an aerofoil tooth back along the flow direction of a working fluid while Libretto prepares the configuration where it sharpened in two or more crownings.
[0011] The path eddy which generated in (a) turbine leading edge with the above-mentioned (1) means, and the axial-flow-turbine aerofoil of this invention moved onto the aerofoil tooth back Although the high-speed fluid in the location distant from the aerofoil tooth back is involved in near an aerofoil tooth back like the conventional axial-flow-turbine aerofoil, that this high-speed fluid contacts an aerofoil tooth back directly becomes only the field where the crowning of Libretto prepared on the aerofoil tooth back of the turbine blade of an exfoliation field sharpened. Furthermore, the high-speed fluid involved in and accelerated by the path eddy is slowed down by Libretto, and a velocity gradient becomes small.
[0012] Wall friction produced at an aerofoil tooth back can be made small by this, and loss of movement of a high-speed fluid etc. can be made small. Moreover, since the large pressure-loss fluid of pressure loss generated by friction with Libretto flows to the downstream along with Libretto, without being swept out in the direction of a center in aerofoil height, the high-speed fluid involved in near the wall surface will flow through the big fluid of pressure loss between aerofoil tooth backs by the path eddy. Thus, it is eased and the velocity gradient of the direction where the aerofoil tooth back near the aerofoil end wall on the tooth back of an aerofoil is perpendicular can control generating of loss by the wall friction in an aerofoil tooth back.
[0013] Moreover, the axial-flow-turbine aerofoil of this invention was made into the following means.
(2) Along with the aerofoil tooth-back side of the turbine blade which is set up by the aerofoil end wall in a hoop direction, and forms a cascade, flow to the downstream. In order to control the migration from the turbine leading edge of a path eddy to an aerofoil tooth-back top and to perform pressure loss reduction on an aerofoil tooth back, and pressure loss reduction by the weakened path eddy itself It generated in the first transition of the turbine blade near the aerofoil end wall, and the bypass path penetrated from aerofoil intrados to an aerofoil tooth back was established in the first transition section of a turbine blade from the location where the path eddy which extends and flows to the aerofoil tooth-back side of the turbine blade adjoined within a cascade flows to the downstream, and crosses an aerofoil tooth back. in addition, a bypass path -- the direction of a code -- an unit -- or you may make it

prepare more than one, and may make it prepare in multistage covering the span direction further

[0014] The bypass path penetrated to an aerofoil tooth back is established in the turbine blade from aerofoil intrados, and the path eddy which generates the axial-flow-turbine aerofoil of this invention with the above-mentioned (2) means in the first transition of a turbine blade can also weaken eddy reinforcement while the migration by the side of an aerofoil tooth back is controlled, since the bypass flow which flows from aerofoil intrados to an aerofoil tooth back by differential pressure occurs in a bypass path.

[0015] That is, if the bypass flow direction is seen of the component of the aerofoil pitch direction in near an aerofoil end wall, since it will turn into a secondary flow direction and the direction of the vortex tube of a path eddy, and reverse sense, bypass flow will control development of a path eddy, and migration of a up to [the aerofoil tooth back of a path eddy]. In order that migration of a up to [the aerofoil tooth back of a turbine blade where the path eddy adjoined and has been arranged from the aerofoil end wall of the turbine leading edge by this] may move to the downstream on the tooth back of an aerofoil, in an aerofoil tooth back, the large field of the wall friction in the aerofoil tooth back generated when a path eddy involves a high-speed fluid in near an aerofoil tooth back becomes small, frictional resistance decreases, and reduction of the pressure loss of a working fluid is attained in connection with this. Furthermore, the eddy reinforcement of the path eddy by bypass flow itself is also weakened, and the friction loss and pressure loss on an aerofoil tooth back are reduced by this.

[0016]

[Embodiment of the Invention] Hereafter, one gestalt of operation of the axial-flow-turbine aerofoil of this invention is explained based on a drawing. The partial perspective view in which drawing 1 shows the 1st gestalt of operation of the axial-flow-turbine aerofoil of this invention, and drawing 2 are the sectional views of the axial-flow-turbine cascade internal flow in connection with the 1st gestalt of operation shown in drawing 1 . In addition, the same sign is given to the same member as drawing 5 mentioned above and the axial-flow-turbine aerofoil shown in drawing 6 , or a similar member, and explanation is omitted.

[0017] In drawing 1 and drawing 2 , 11 attaches notches, such as about 0.05mm V typeface, in parallel with the flow direction of Libretto and the high-speed fluid 9 prepared several many steps in parallel with flow, is surrounded by the path eddy 7 and the aerofoil end wall 2 which are extended on the aerofoil tooth back 5, and is installed in the exfoliation field S of the triangle formed in the trailing-edge side of a turbine blade 1.

[0018] As shown in a detail, while two or more formation of the configuration where the crowning of Libretto 11 sharpened keenly is carried out, he is trying to prepare it in the exfoliation field on two or more and the tooth back 5 of an aerofoil in drawing 2 , as the configuration where it sharpened keenly is arranged at pitches [location / of the span direction / every / abbreviation fixed]. moreover, in the slot (notch) which it comes to insert into Libretto 11, the pressure-loss fluid 10 which became large [pressure loss] exists, and it passes to a back-wash side in parallel with Libretto 11.

[0019] According to the axial-flow-turbine aerofoil of the gestalt of this operation, the path eddy 7 extended to the aerofoil tooth back 5 like the conventional axial-flow-turbine aerofoil Although the high-speed fluid 9 in the location distant from the aerofoil end wall 2 and aerofoil tooth-back 5 wall surface is involved in near the aerofoil tooth-back 5 top It is accelerated by entrainment, and that the high-speed fluid 9 with which the velocity gradient became large contacts the aerofoil tooth back 5 directly becomes only the field where Libretto 11 crowning sharpened, and wall friction by friction with the aerofoil tooth back of the high-speed fluid 9 can be performed small, and can make small loss of the momentum of the high-speed fluid 9.

[0020] That is, the velocity gradient of a direction perpendicular to the aerofoil tooth back 5 generated near [aerofoil end-wall 2] the aerofoil tooth back 5 can control generating of the pressure loss of the high-speed fluid 9 by reducing the wall friction in the aerofoil tooth back 5 by making a touch area small while being eased by Libretto 11.

[0021] Moreover, the large pressure-loss fluid 10 of pressure loss generated by friction with Libretto 11 In order to flow to a lower stream of a river along the inside of the notch of Libretto 11, without being

swept out in the direction of a center in aerofoil height, the high-speed fluid 9 involved in near the wall surface by the path eddy 7 Mixing with the pressure-loss fluid 10 is controlled, and the high-speed fluid 9 flows into the downstream, without producing pressure loss, in order to flow through the pressure-loss fluid 10 between the aerofoil tooth backs 5.

[0022] thus, with the axial-flow-turbine aerofoils of the gestalt of this operation By forming Libretto 11 in the exfoliation field S inserted into the aerofoil end wall 2 and the path eddy 7 on the aerofoil tooth back 5 While being able to ease the velocity gradient of the high-speed fluid 9 of a direction perpendicular to the aerofoil tooth back as for which induction is carried out by the secondary flow eddy in an exfoliation field and being able to control generating of loss by wall friction Mixing with the high-speed fluid 9 and the pressure-loss fluid 10 can be controlled, the pressure loss of the high-speed fluid 9 can be reduced, and large improvement in a turbine efficiency can be aimed at.

[0023] Next, the partial perspective view in which drawing 3 shows the 2nd gestalt of operation of the axial-flow-turbine aerofoil of this invention, and drawing 4 are the sectional views of the axial-flow-turbine cascade internal flow in connection with the 2nd gestalt of operation shown in drawing 3 .

[0024] Also in these drawings, the same sign is given to the same member as drawing 5 mentioned above and the axial-flow-turbine aerofoil shown in drawing 6 , or a similar member, and explanation is omitted. In drawing 3 and drawing 4 , 12 is a bypass path and 13 is bypass flow. It generates from the first transition of a turbine blade 1, and he is trying for the vortex tube of the path eddy 7 extended to up to the aerofoil tooth back 5 of the turbine blade 1 which adjoins by the secondary flow 6 to prepare in the aerofoil end-wall 2 neighborhood at one or more chordwises, bypass applying it to the first transition from the location which crosses the intersection on the aerofoil end wall 2 and the tooth back 5 of an aerofoil to a turbine blade 1, so that a turbine blade 1 may be penetrated from the aerofoil intrados 4 to the aerofoil tooth back 5.

[0025] As shown in drawing 4 , in the bypass path 12 which the path eddy 7 flowing out had on the abbreviation wing-tip wall 2, and was made to penetrate to a turbine blade 1 to the aerofoil tooth back 5, and prepared the part which forms the bypass path 12 in it from the aerofoil intrados 4, the bypass flow 13 occurs by the differential pressure between the aerofoil intrados 4 and the aerofoil tooth back 5. If the sense of the bypass flow 13 is seen of the component of the aerofoil pitch direction in the aerofoil end-wall 2 neighborhood, since it will turn into the direction of the secondary flow 6 and the direction of the vortex tube of the path eddy 7, and reverse sense, the bypass flow 13 While weakening the eddy strength of the path eddy 7 and controlling development of the path eddy 7, migration of a up to [the aerofoil tooth back 5 of the path eddy 7 generated in the first transition of the adjoining turbine blade 1] is controlled.

[0026] The path eddy 7 which moves to up to the aerofoil tooth back 5 of the turbine blade 1 which occurred and has been adjacently arranged by the aerofoil end wall 2 of the first transition of a turbine blade 1 by this Without moving in the direction of a center in the span direction, i.e., aerofoil height, about two aerofoil end wall on the tooth back 5 of an aerofoil will be moved to the downstream, and it sets at the aerofoil tooth back 5. The exfoliation field S of the wall friction in an aerofoil tooth back which is generated by involving the high-speed fluid 9 which the path eddy 7 mentioned above in the aerofoil tooth-back 5 neighborhood and which becomes large becomes small, friction loss decreases, and reduction of the pressure loss of a working fluid F is attained in connection with this. Furthermore, with the weakened eddy reinforcement of path eddy 7 the very thing by the bypass flow 13 mentioned above, the friction loss and pressure loss on the aerofoil tooth back 5 can be reduced, can reduce the pressure loss of the high-speed fluid 9, and can aim at large improvement in a turbine efficiency.

[Translation done.]

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The partial perspective view showing the 1st gestalt of operation of the axial-flow-turbine aerofoil of this invention,
[Drawing 2] The sectional view of the axial-flow-turbine cascade internal flow in connection with the 1st gestalt of operation shown in drawing 1 ,
[Drawing 3] The partial perspective view showing the 2nd gestalt of operation of the axial-flow-turbine aerofoil of this invention,
[Drawing 4] The sectional view of the axial-flow-turbine cascade internal flow in connection with the 2nd gestalt of operation shown in drawing 3 ,
[Drawing 5] The mimetic diagram showing the situation of the flow inside the cascade of the conventional axial-flow-turbine aerofoil which set up the turbine blade to the hoop direction and was prepared in the aerofoil end wall,
[Drawing 6] It is a sectional view to show the detail of the flow near [on the tooth back of an aerofoil of a turbine blade] the aerofoil end wall among the internal flows of the conventional axial-flow-turbine cascade shown in drawing 5 .
[Description of Notations]
1 Turbine Blade
2 Aerofoil End Wall
3 Horseshoe Vortex
4 Aerofoil Intrados
5 Aerofoil Tooth Back
6 Secondary Flow
7 Path Eddy
8 Path between Aerofoils
9 High-speed Fluid
10 Pressure-Loss Fluid
11 Libretto
12 Bypass Path
13 Bypass Flow
F Working fluid
S Exfoliation field

[Translation done.]